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A CONTRIBUTING STUDENT PEDAGOGY: CAN ENCOURAGING STUDENTS TO CONTRIBUTE THEIR OWN QUESTIONS AND ANSWERS TO A MULTIPLE CHOICE QUESTION BANK HELP BOOST ENGAGEMENT AND INTERACTION IN THE CLASSROOM

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Abstract

In this paper, we describe the preliminary ways in which we have extended our mobile system, QUBED, an in-house Multiple Choice System, which is used to encourage students to build a question bank of multiple choice questions (MCQ) that will be used by their peers. They will be able to build questions and set quizzes that will be taken and rated by other classmates. As their usage increases they are awarded various 'points' for the way in which they interact with the system. These points are 'rewards' for participating in building and enhancing the social capital held within the system. The system monitors student engagement and maintains a leader-board of activities so all students can see how they compare with their peers. It is envisioned that this will add a useful competitive edge to the usage of the system as it should have an effect on how a person is viewed by others in the group, and is likely to help enhance their productivity, wellbeing and self-image.

The introduction of the leader-board scenario from games playing will be explored to assess the usefulness and appeal of using such a tool in a learning environment. Case studies in the commercial sector have shown that the concept of gamification can have a positive impact on engagement. EMC² embarked on a drive to increase customer participation resulting in the development of their Recognition, Awards and Motivation Program (RAMPS). The program had the desired effect; resulting in increased interaction between the company and its customers. Likewise Deloitte applied a similar approach to their Leadership Academy; including ranking, rewards, missions, and leader-boards achieving improved participation rates and, equally interesting, improved participant returns and retention rates. Ultimately we are interested in the student's ability to learn and not just how well they have used the system so the emphasis is still based on the formative feedback aspects of the original system.

Keywords: CSP, MCQ, Question bank, social capital, leader-boards, engagement, pointsification.

1 INTRODUCTION

In this article we consider ways in which we have extended our original QUBED (Questioning Utilising Broad Evaluation and Discussion) system [1], [2] for enhancing engagement opportunities in the classroom by extending the functionality to further those activities. Firstly, the ideas of a Contributing Student Pedagogy (CSP) [3] are explored and secondly the consideration of adding game elements to the system are outlined [4].

1.1 QUBED System

One of the earliest concepts we had was to develop a piece of software that could be delivered on a range of PC and mobile platforms building on the ideas of Automatic Response Systems. From the inception, it was decided that each student should be able to get involved by using their own smartphone [5] rather than using University 'clicker' devices. It was expected that the student would not only use this software in the timetabled classes, but also be able to be used out of timetabled hours, at home or elsewhere on campus. Our early assumptions focused on the idea that most students had not made strong connections for themselves between their personal smartphones and their needs as learners and the way they could be used to help them learn.

The primary requirements for the hardware/software were as follows:

- Portability: The software was required to be able to run on a range of PC and mobile devices.
- Cost: It was essential to keep the system costs to a minimum and so we used existing hardware to support the web server and hosting. The students would carry the brunt of the

costs but they would already have had a pc or mobile device – certainly much cheaper than the specialist kit that was required for the existing clicker system. One of the objectives of our Audience Response System (SRS) was to replace the use of “clicker” devices with the students’ smartphone and/or tablet.

- Engagement and Interaction opportunities: From the outset of this system build we have been actively trying to improve the engagement opportunities of our students.
- Modular design: The design of the system needed to be modular in nature, so elements could be used with different types of questions.
- Assessment: an ability to use the system as both a formative and summative tool where students would answer MCQ’s either on their own or as part of a quiz set.
- Feedback: an ability to provide immediate feedback to the student in the form of answers shown in a diagrammatic way and feedback for staff showing how their students are understanding topics.

1.2 Multiple Choice Questions (MCQ’s)

The decision to use Multiple Choice Questions (MCQ’s) as the basis of our questioning ‘BACDE’ approach was an easy one to make as MCQ’s are a particularly convenient form of assessment in classroom situations. They can be used to efficiently assess various levels of learning outcomes, from basic memorization of facts to higher order skills such as application, analysis, and evaluation. Because students are choosing from a set of potential answers, however, there are obvious limits on what can be tested with multiple choice items. That said, multiple choice tests aren’t as prone to guess work as true/false questions, thus making them a more reliable means of assessment. After students submit their responses, the system displays a histogram of the selected answer choices. Without first revealing the correct answer, the teacher discusses the question and answers with the class.

The building of MCQ’s is not a trivial matter and can take time in producing an appropriate question stem along with a set of distractors and a correct answer option. In previous work by Paterson et al [6] researching contributions by students to a question bank of MCQ’s it was suggested that staff need to be actively involved at an early stage to convey expectations of what is required about the number and types of contributions and more particularly how to author good questions.

2 LITERATURE REVIEW

According to Biggs’ 3P model [7], good interaction between the student and teaching contexts will encourage a deeper approach to learning. Chickering and Gamson [8] also illustrated the importance of interaction in learning with five of their seven principles being directly related to interaction among (1) the participants in the learning process and (2) the participants with the subject matter:

- contacts between students and faculty
- reciprocity and cooperation among students
- prompt feedback
- emphasis on time on task
- communication of high expectations.

Most students are generally motivated by what is going to count towards their final mark. However, even though formative assessment does not contribute directly to a summative mark, it should be emphasised to them that it can play a vital role in helping to improve their grades and has considerable potential for enhancing their overall achievement. Formative assessment is essential to learning in its aim is to give appropriate and timely feedback to students on their learning, and to help them to improve their future work [9]. There is strong evidence that what William and Thompson [10] term “short-cycle” formative assessments—can have a profound impact on student achievement.

The use of computer games has become a more recent way to help students to learn [11] both in formal and informal settings. They can be used in a variety of pedagogical ways by being problem-solving in nature, or by allowing users to work collaboratively or just the fact that they often simulate real world scenarios. Complex simulation software such as flight simulators or medical training applications are commonly used to approximate real professional practice but they are no more than an attempt to allow users to build up their skills and knowledge as they move from novice to expert user. Nonetheless, these experiential learning tools are essential as they allow individual users to grapple with problems at their own pace, in a safe and non-threatening environment. These types of

games allow users to explore and make sense of the situations they are presented with in a meaningful context. This ability to try things out forms a central part of the Experiential Cycle [12]. Kolb suggested that students learn better by discovering and engaging in experiences for themselves. He believed that the learners' experiences are followed by a period of reflection which leads to the formation of abstract ideas which helps them to solve problems. This 'learning' by observation or reflection can then lead to an action being carried out.

Not all training materials need to be as sophisticated as simulation software or as expensive. Traditional board and card games have been used in teaching because they are relatively inexpensive, easy to play and learn and can be very effective in helping children to count or work with letters or build up social skills in learning how to communicate with others. These skills of communication, negotiation and an ability to work collaboratively are key life-long transferrable skills which are equally important for our students and should be actively encouraged. Vygotsky [13] described the notion of learning through others as part of his ideas on the 'Zone of Proximal Development' (ZPD). The ZPD was described as the difference between what one can learn on ones' own and what one can learn with the help of a more 'knowledgeable other' e.g. a teacher or mentor or even just a more able student. These ideas of collaborative learning, in terms of social interaction involving a community of learners and instructors, fits well with the ideas of students as collaborators and co-constructors of course materials.

Hamer [14] explained that a Contributing Student Pedagogy (CSP) is an approach in which students contribute to the learning of others, and value the contribution of others. The use of student-generated questions for learning is one example of this approach, and has a wide range of documented benefits, including development of a deeper understanding of the subject content learned, shift from acquiring knowledge to using knowledge and developing a sense of ownership of the subject content as well as their learning experience [15]. Denny [16] introduced PeerWise, a software tool, which provides support for student-generated multiple choice questions. It allows students to write MCQs that build towards an online repository of questions. Students can answer questions which have been contributed by others, and consider those contributions. The authors of the PeerWise system assert that asking students to write MCQs, and to provide appropriate explanations gives a richer and deeper learning experience than simply answering practice questions which have been provided by staff.

In recent years game development programmes at Universities and Colleges have become increasingly common whilst it could be argued that Computer Science programmes have stalled or decreased in numbers of applicants. Many instructors now recognize that game development can be a persuasive way to motivate students to learn and some instructors have introduced the gameful elements of games technology to their teaching environments to help teach computing concepts such as programming, cf. Leutenegger and Edgington [17], and software engineering, cf. ClayPool and ClayPool [18]. Additional research by Bayliss and Strout [19], Khuravski [20] and Linhoff et al [21] shows that game development is an effective motivator for computer science assignments, curricula, and undergraduate research. Chaffin and Barnes [22] indicated that the literature on game development courses emphasizes that students learn computing concepts through increased motivation combined with the need to integrate many computing concepts into one piece of software that is small enough for students to visualise.

According to Deterding et al [23] 'gamification' has experienced significant growth in popularity in the last few years with the introduction of game elements to existing systems. The use of game elements such as the introduction of points and leader-boards aim to increase the engagement levels of the users of such systems. Other artefacts that can be used to gamify an activity include the use of experience levels, badges and tokens. Leader-boards consist of a list of participants, ordered by the highest to the lowest scores, and can be viewed in different ways such as all-time standings based on weekly or daily rankings for one or more activities. These techniques are known to stimulate and promote competitiveness and engagement between the players participating in naturally competitive activities, while gauging the competence of the contributor, Crumlish and Malone [24], and have been applied to a variety of settings including education, Kapp [25], with the design of many mobile applications suitable to run on mobile platforms such as smartphones and tablets in a drive to achieve stronger user engagement, Pedreira et al [26]. Ultimately the more students practice and get feedback on their writing, analysing, or problem solving, the more adept they should become; Kuh [27].

Research by Augustin et al. into the gamification of enterprise systems found in industry has identified the following common mechanics and dynamics: feedback, goals, badges, point systems, leaderboards, and user levels [28]. Urh et al. [29] model for the introduction of gamification into the field of e-learning also identifies the same mechanics and dynamics adding levels, status and

competition. It is suggested that the introduction of reward elements such as badges, points and rankings are the type of reward elements that can be integrated into systems to pique the learner's extrinsic motivation [30].

Deloitte Leadership Academy (DLA) provides access to training for over 50,000 executives across 14 countries using an online portal and mobile applications [31]. In order for Deloitte to maintain freshness for its training delivery and to maintain the users focus and interest they embarked upon a joint venture with the gamification company Badgeville. This collaboration led to the introduction of Badges, goals, points system and leader board [28] to motivate the learners and attempt to introduce a degree of longevity [32]. Augustin et al. [28] notes that the DLA platform requires the learner to personalise their profile according to their individual "learning priorities"; this, they suggest, "helps to bind" the learners to the system. Goals provide a clear path towards the learner's objectives; badges and points appear on the learner's profile page and leaderboards/rankings are compiled for each learning topic [28].

As part of this solution Badgeville also implemented an "instant feedback" mechanism which can bolster the learning effect and underline the perception of improvement [33] [28]. Initial results obtained after the platform had been live for three months suggest that the gamification of the platform has achieved the desired affect with learner's daily revisit increased by almost 50% and a weekly revisit increased by 36%; learners averaging three badges and one learner attaining the "Graduate" badge which would normally take 12 months to achieve [33] [34].

EMC, a Dell Technologies company, with the help of Badgeville set about gamifying their community network [34] [35]. To do this they developed the RAMP system: Recognition, Awards and Motivation Program. The system attempts to recognise an individual's participation within the community. Badges, missions and a points based system are used to encourage company employees to interact and achieve "unique rewards" [35]. Badgeville created numerous achievements for the system users to unlock as well as multiple walk through missions [33].

These particular case studies certainly suggest that gamification can provide the learner with motivation to achieve and participate in their own learning.

3 METHODOLOGY

The original BACDE framework (Table 1) highlighted by usage of our QUBED (Questions Utilising Broad Evaluation and Discussion) system still forms the centrepiece of our pedagogy.

<u>Process</u>	<u>Who</u>	<u>When</u>
BUILDing the question	Lecturer	Before
ASKing the question	Lecturer / Student	During
CONSIDERing the question	Student	During
DISCUSSing the question	Lecturer / Student	During
EVALUATEing the question.	Lecturer / Student	After

Table 1 BACDE Framework

Student surveys or questionnaires are a useful tool for staff because they can provide insights into the student experience and/or perception. They can garner the likelihood or otherwise of a set of students being able or willing to 'do something or not'. We used the QUBED system to deliver a set of questions that encouraged us to expand the system to include 'additional learning opportunities' for our students.

The authors administered the questionnaires to two different cohorts of students i) a 2nd year class of 16 networking students on the Visual Software Development module and ii) a 2nd year class of 42 games students on the Games Programming module. They were distributed in April 2015 near the end of the 2 trimester of the 15-16 Academic year. Approximately 47 of the total 58 students replied.

	Q. I'm not comfortable using social networking to enhance my learning experience – id = 8112953	Q. I think GCU Learn should be accessible from within social networking sites - id=8112964
<u>option label</u>	<u>% choice (count)</u>	<u>% choice (count)</u>
strongly disagree	6.38 (3)	11.11 (5)
disagree	14.89 (7)	11.11 (5)
neutral	29.78 (14)	35.55 (16)
agree	27.65 (13)	22.22 (10)
strongly agree	21.27 (10)	20.1 (9)

Table 2

	Q. I don't believe that using technologies will help me learn better – id = 8112954	Q. I don't think I would use technology in the classroom to help me learn – id = 8112956
<u>option label</u>	<u>% choice (count)</u>	<u>% choice (count)</u>
strongly disagree	72.34 (34)	68.08 (32)
disagree	17.02 (8)	19.15 (9)
neutral	6.38 (3)	12.76 (6)
agree	0.0 (0)	0.0 (0)
strongly agree	4.26 (1)	0.0 (0)

Table 3

From these results almost 90% of our students think that the use of technology can or will help our students to learn.

	Q. I would use a mobile device to help me learn – id = 8112958	Q. I'm happy to use technology in the classroom to help me learn - id=8112963
<u>option label</u>	<u>% choice (count)</u>	<u>% choice (count)</u>
strongly disagree	2.13 (1)	4.16 (2)
disagree	6.38 (3)	0.0 (0)
neutral	10.63 (5)	10.41 (5)
agree	29.78 (14)	27.08 (13)
strongly agree	51.06 (24)	58.33 (28)

Table 4

From these results about 80% of our students positively agree with the use of mobiles and general technologies to help them learn.

	Q. I'm confident in using technology in my learning – id = 8112960	Q. I'm confident in using technology to learn – id = 8112961	Q. Learning technologies would not help me to learn – id = 8112962
option label	% choice (count)	% choice (count)	% choice (count)
strongly disagree	0.0 (0)	0.0 (0)	68.08 (32)
disagree	0.0 (0)	2.13 (1)	21.3 (10)
neutral	8.51 (4)	6.38 (3)	4.25 (2)
agree	25.53 (12)	19.14 (8)	2.13 (1)
strongly agree	65.96 (31)	72.34 (34)	4.25 (2)

Table 5

From these results about 90% of our students say that they are confident in using technology as part of their learning and similarly almost 90% of our students disagreed with the question asking if they wouldn't learn anything with the use of learning technologies.

The outcome of this set of questionnaires encouraged us to push ahead with our ideas of using technology in the classroom to continue to support interactivity and engagement and to broaden the activities that were available to the students and for the students. The incorporation to our QUBED system of ideas discussed in the literature review about including game elements and contributory student concepts brings together some of the previous work that the authors have in these areas Law [36] and Devon et al [37].

The inclusions of awarding points for achieving various tasks allowed us to build a leader-board so users could see how their contributions relate to other users. Similarly, other rewards can be introduced for performing a variety of tasks and the number of performances leading to the concept of badges.

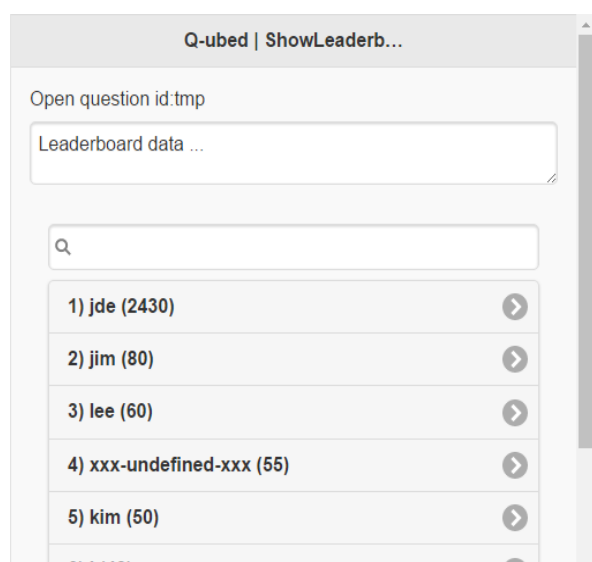


Figure 1 Example Leader board

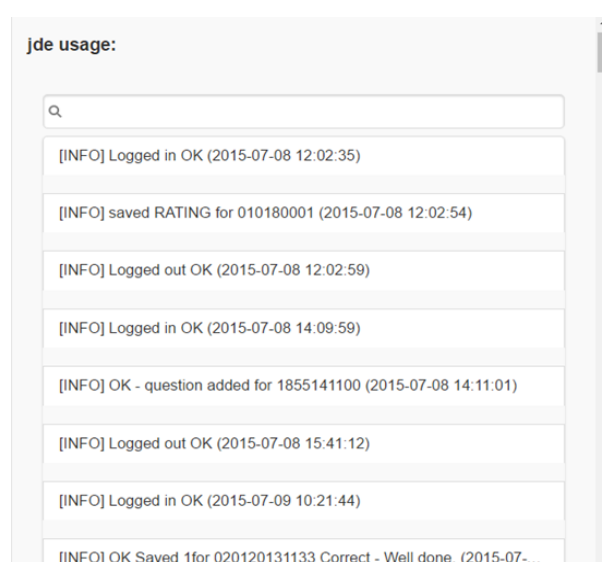


Figure 2 leader-board drilled down into by user

Figure 2 shows an example of a leaderboard, identifying the username and the current number of points accumulated (NB jde is a system admin username which is why the number of points is much larger than the others shown.) In Figure 3 we can see a variety of activities that user jde has carried out and when they occurred:

- Logging into and out of the system
- Rating a question
- Adding a new question
- Answering a question

4 DISCUSSION AND FUTURE WORK

Student feedback will centre on ascertaining the students perceived feeling of engagement with the system, their perception of ease of use of the system and if they felt the system had improved their understanding of the material presented. Staff feedback will centre on the use staff made of the system, its ease of use and the time management requirements of using the system in a lecture situation. Usage and participation statistics will help identify such possibilities as over use of the system, degree of difficulty of the questions being posed e.g. too easy, too difficult and if there was any degradation in student participation rates. Users can currently rate questions based on a 'smiley face' system based around a five-point Lickert scale and these ratings will be used to build a numeric value for each question that will be used to identify a difficulty ranking.

MCQ contribution requests produced only 1 student who added a question with many students viewing the question– note that no marks were allocated for the task and students did not respond to requests to say why they did not take part. The ironic part was that the students made a specific request for one of the authors to include MCQ's for them to learn rather than just have the usual open questions for their tutorials. This seemed to back up previous work that showed many students are not motivated enough unless some sort of reward or recognition system is in place.

Currently the QUBED system is based on Questions, Questionnaires and Quizzes (Q³). We are discussing ideas to extend the system to incorporate Quests (Q⁴) where the idea of a Quest will have users searching for or trying to achieve a specific set of tasks e.g. answer four questions correctly in a row to earn some sort of reward or contribute four questions to get your beginners 'badge'. The feedback mechanism will be enhanced to offer more expansive feedback as this helps to encourage and motivate the learner. Incorporating a points system, levels and a leaderboard will help to encourage and motivate the learner in a social context; attempting to engender a feeling of community. The incorporation of the aforementioned gameful ideas will, we hope, extend the QUBED system into additional fields of research.

Similarly, an area of future work and integration within the system is Open Badges. As noted by Law [36] Open Badges are portable and can be stored by the student in their "backpack" and shown to employers as a means of recognition. Open Badges are digitally stamped by the providing institution as a means of verifying their authenticity. Open Badges are seen [36] as a good motivational tool and have been used by Badgeville as part of their gamification of Deloitte Leadership Academy [31] and EMC community Network [35].

5 CONCLUSIONS

The continued expansion of the original QUBED system has allowed the authors to continue to explore ways in which we can bring together ideas from other areas of research that we have been pursuing; particularly with respect to CSP and gamification. Students agreed that using Automatic Response System ideas in the form of our mobile application were easy to use and a useful tool for providing real-time feedback. We found ARS to be an effective assessment tool benefiting both the staff and the students in a curriculum focused on interaction and self-directed learning.

Asking students to contribute MCQ's, even though the possibility that questions may be poorly thought out, or that their answers may be wrong, gives students an opportunity to practice multiple skills in arguing and demonstrating learned knowledge as part of an active learning approach. MCQ's are often used to measure three levels of Bloom's Taxonomy including knowledge, understanding and application of facts and figures. However, they can also be used to help students to analyse and evaluate scenarios and contexts.

If the instructor of the course has minimal time to prepare for the introduction of gameful elements to a system or programme then it is probably better to wait and prepare appropriately. Alternatively, the instructor could use simple games that are well known as we believe the biggest hurdle to overcome in using games in introductory computer science courses is the amount of work that is involved for those who want to use games while meeting traditional course outcomes throughout the course.

Huang and Soman [38] suggest a five step approach to applying gamification in an educational setting as shown in figure 3.

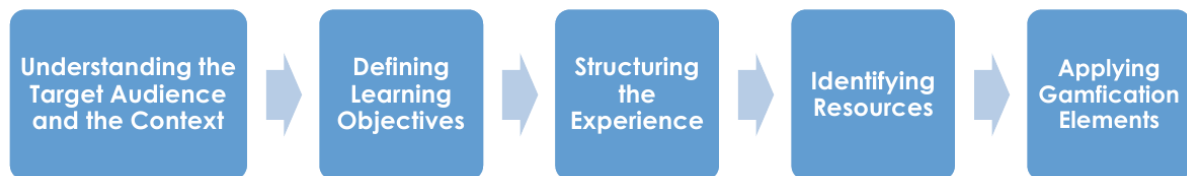


Figure 3 Five step gamification approach

This approach seems a good fit for the work that we have already been doing to incorporate the elements of gamification within our system. The literature review indicates that students learn through playing games and the five step process seems a natural progression that should suit the academic thought process. As with [28], [29] and [30] Huang and Soman [38] also suggest feedback, goals, badges, point systems, leaderboards, and user levels as suitable gamification elements.

Our preparatory work and readings in this area show that gamification of existing systems is worth pursuing as it can be used to grab students' attention and actively engages them in their learning. We intend to do future evaluations related with teaching and learning methodologies, in order to improve, add or exclude some system features. We will continue to explore and evaluate the ideas and it is our intentions to explore further the pedagogy behind those ideas. Ultimately we are interested in the student's ability to learn and not just how well they have used the system so the emphasis is still based on the formative feedback aspects of the original system.

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